Memorandum

Date: April 19, 2012

From: Alice Lovegrove

Subject: GHG Analysis for Phase 1 Blended – High and Low Scenarios.

Introduction:

On April 12, 2012, the High Speed Rail Authority passed the revised 2012 Business Plan for the High Speed Rail Project. In this plan, a blended approach to the project for the urbanized book-end sections was introduced. The blended system approach represents a combination of dedicated high speed train tracks with upgraded existing track systems. The analyses presented in the current environmental documents to date do not reflect the differences in GHG benefits with the Phase 1 Blended approach. As such, it was requested that an analysis be conducted to determine the greenhouse gas (GHG) benefits of the Phase 1 Blended approach. This memo presents the methodology, data and results of this analysis.

Data and Methodology:

Revised data for energy consumption, roadway vehicle miles traveled and diverted airplane trips was provided by the developers of the Business Plan. These numbers were based on travel demand modeling developed by Cambridge Systematics. Trainset miles developed for the Blended Alternative are presented in Figure 1 beginning with the year 2025. Values for the year 2025 represent a shorter Initial Operating Section.

Figure 1 – Trainset Miles

HIGH RIDERSHIP, REVENUE, AND O&M COSTS

		2025	2030	2035	2040	2045	2050	2055	2060
Ridership	(in millions)	10.47	26.76	31.78	32.59	33.41	34.25	35.12	36.00
Trainset Miles	**(in millions of miles)**	**8.87**	**21.14**	**25.34**	**25.34**	**25.64**	**27.14**	**27.70**	**27.70**
Passenger Miles	(in millions of miles)	2,484	7,438	8,833	9,056	9,285	9,519	9,760	10,006

LOW RIDERSHIP, REVENUE, AND O&M COSTS

		2025	2030	2035	2040	2045	2050	2055	2060
Ridership	(in millions)	5.80	16.12	19.63	20.13	20.63	21.16	21.69	22.24
Trainset Miles	**(in millions of miles)**	**5.02**	**14.01**	**16.43**	**16.65**	**17.68**	**17.91**	**18.08**	**18.52**
Passenger Miles	(in millions of miles)	1,359	4,371	5,324	5,459	5,597	5,738	5,883	6,031

Based on these trainset miles, the energy requirements for the train and related facilities were calculated for the years 2030, 2035 and 2040. These values are presented in Table 1.

Table 1 – Power Requirements
GWh per day/GWh per Year

Scenario	2030	2035	2040
High Ridership	3.46 / 1,300	4.15 / 1,500	4.15 / 1,500
Low Ridership	2.29 / 800	2.69 / 1,000	2.72 / 1,000

Source: PMT

Using EPA's egrid values for GHG emissions as shown in Figure 2, the power requirements were multiplied by the appropriate emission factor, as highlighted in Figure 2, to calculate the amount of GHG emissions generated due to the power requirements of the project.

Figure 2 – eGRID2010 GHG Emission Rates

eGRID subregion acronym	eGRID subregion name	Annual total output emission rates			Annual non-baseload output emission rates		
		Carbon dioxide (CO_2) (lb/MWh)	Methane (CH_4) (lb/GWh)	Nitrous oxide (N_2O) (lb/GWh)	Carbon dioxide (CO_2) (lb/MWh)	Methane (CH_4) (lb/GWh)	Nitrous oxide (N_2O) (lb/GWh)
AKGD	ASCC Alaska Grid	1,284.72	27.11	7.44	1,363.19	34.99	6.95
AKMS	ASCC Miscellaneous	535.73	22.65	4.48	1,462.30	61.68	12.18
AZNM	WECC Southwest	1,252.61	18.80	16.57	1,211.84	20.56	9.31
CAMX	WECC California	681.01	28.29	6.23	1,045.30	39.42	4.74
ERCT	ERCOT All	1,252.57	17.76	13.99	1,096.19	19.69	5.63
FRCC	FRCC All	1,220.11	41.19	15.25	1,286.41	43.40	11.50
HIMS	HICC Miscellaneous	1,343.82	135.15	21.71	1,645.57	122.94	21.33
HIOA	HICC Oahu	1,620.76	91.05	20.89	1,630.89	106.18	18.52
MROE	MRO East	1,692.32	28.79	29.05	1,905.18	35.25	29.98
MROW	MRO West	1,771.52	29.50	29.99	1,988.69	53.59	32.98
NEWE	NPCC New England	827.95	76.98	15.20	1,204.91	60.69	13.41
NWPP	WECC Northwest	858.79	16.34	13.64	1,279.58	43.31	15.75
NYCW	NPCC NYC/Westchester	704.80	26.22	3.35	1,234.06	37.65	4.88
NYLI	NPCC Long Island	1,418.74	90.50	13.10	1,397.80	44.08	6.99
NYUP	NPCC Upstate NY	680.49	17.41	9.90	1,378.53	31.55	16.19
RFCE	RFC East	1,059.32	27.40	17.03	1,671.96	33.29	22.19
RFCM	RFC Michigan	1,651.11	32.55	27.79	1,803.64	32.09	27.33
RFCW	RFC West	1,551.52	18.37	25.93	1,982.05	24.30	31.48
RMPA	WECC Rockies	2,187.41	26.69	33.47	1,554.38	23.17	16.45
SPNO	SPP North	1,798.71	21.22	29.20	1,958.22	25.40	27.75
SPSO	SPP South	1,624.03	24.52	22.42	1,435.24	25.03	13.14
SRMV	SERC Mississippi Valley	1,004.10	21.80	11.15	1,171.05	28.25	6.91
SRMW	SERC Midwest	1,779.27	20.57	29.60	1,945.66	24.02	29.69
SRSO	SERC South	1,495.47	23.64	24.57	1,551.05	28.50	21.69
SRTV	SERC Tennessee Valley	1,540.85	19.87	25.48	1,917.25	25.98	30.05
SRVC	SERC Virginia/Carolina	1,118.41	22.26	19.08	1,661.11	38.01	24.51
SRVC	SERC Virginia/Carolina	1,118.41	22.26	19.08	1,661.11	38.01	24.51
U.S.		**1,299.53**	**25.14**	**19.74**	**1,520.11**	**32.23**	**18.41**

Source: http://www.epa.gov/egrid

Changes in roadway vehicle miles traveled (VMT) estimates due to the project were calculated by Cambridge Systematics for 2030 and projected to the future by the PMT. The overall change in VMT, which includes both inter-county and intra-county travel, is shown in Table 2.

Table 2 – Vehicle Miles Traveled (VMT) Changes

(Millions of Miles Daily/Millions of Miles Annual)

Scenario	2030	2035	2040
High Scenario			
IOS South	-6.6 / -2,000	-6.8 / -2,000	-7.0 / -3,000
Bay to Basin	-10.3 / -4,000	-10.6 / -4,000	-10.9 / -4,000
Blended*	-11.6 / -4,000	-11.9 / -4,000	-12.2 / -4,000
Phase 1	-12.9 / -5,000	-13.2 / -5,000	-13.6 / -5,000
Low Scenario			
IOS South	-3.4 / -1,000	-3.5 / 1,000	-3.5 / -1,000
Bay to Basin	-6.1 / -2,000	-6.2 / -2,000	-6.4 / -2,000
Blended*	-7.3 / -3,000	-7.5 / -3,000	-7.7 / -3,000
Phase 1	-8.5 / -3,000	-8.8 / -3,000	-9.0 / -3,000

**2030 VMT estimates for this alternative represent the ridership build up phase which is estimated to be 55% of the total ridership.*

Emission factors derived from the California Air Resources Board (CARB) EMFAC7 emission factor program for the appropriate years and speeds were multiplied by these VMT reductions, resulting in an estimate of the GHG emissions saved from roadway VMT reductions due to the project.

Diversions in airplane trips were also derived through travel demand modeling developed by Cambridge Systematics and distributed by the PMT. Estimated airplane diversions are presented in Table 3.

Emission Factors from the Federal Aviation Administration (FAA) EDMS model were applied to the number of flights removed to estimate the reduction in airplane GHG emissions due to the project.

Results

The GHG emission burden changes due to the project's impact on power requirements, roadway VMT and airplane trips are summarized in Table 4. The associated changes in energy are summarized in Table 5. The increase in power requirements in 2035 (20% increase in high forecast and 17% increase in low forecast), as compared to the 2030 requirements, negate some of the VMT emission savings, resulting in 2035 having slightly less GHG savings than 2030. By 2040, the power requirements do not increase substantially, as compared to 2035, but the VMT savings do increase, giving 2040 the highest GHG savings of the comparison years.

Table 3 –

Trip and Flight Diversions (Daily Air Trips Removed/Daily # of Flights)

Scenario	2030	2035	2040
High Scenario			
IOS South	5,491/ 54	5,630 / 56	5,772 / 57
Bay to Basin	14,973 / 148	15,352 / 152	15,739 / 155
Blended	17,299 / 171	17,736 / 175	18,184 / 180
Phase 1	19,825 / 196	20,326 / 201	20,839 / 206
Low Scenario			
IOS South	2,519 / 25	2,582 / 26	2,648 / 26
Bay to Basin	7,672 / 76	7,866 / 78	8,064 / 80
Blended	9,372 / 93	9,608 / 95	9,851 / 97
Phase 1	10,767/ 106	11,039 / 109	11,318 / 112

Source: PMT, assumes 101.25 passengers per flight

Table 4 – Draft Comparison of GHG emission changes for HSR Blended –

Years 2040, 2035, 2030

Scenario	CO_2 Daily Changes (Metric Tons/Day)				CO_2 Annual Changes (Metric Tons/Year)			
	Autos	Planes	Power	Total	Autos	Planes	Power	Total
High – Year 2040								
IOS South	-2,629	-214	NA		-959,078	-78,142	NA	
Bay to Basin	-4,099	-584	NA		-1,495,686	-213,083	NA	
Blended	-4,592	-674	1,281	-4,000	-1,672,411	-246,177	463,349	-1,455,200
Phase 1	-5,126	-773	NA		-1,863,284	-282,129	NA	
Low – Year 2040								
IOS South	-1,337	-98	NA		-487,529	-35,845	NA	
Bay to Basin	-2,416	-299	NA		-881,465	-109,178	NA	
Blended	-2,893	-365	842	-2,400	-1,053,293	-133,365	308,899	-877,800
Phase 1	-3,388	-420	NA		-1,230,350	-153,223	NA	
High – Year 2035								
IOS South	-2,562	-209	NA		-934,564	-76,218	NA	
Bay to Basin	-3,995	-569	NA		-1,457,456	-207,835	NA	
Blended	-4,475	-658	1,281	-3,900	-1,629,664	-240,114	463,349	-1,406,400
Phase 1	-4,995	-754	NA		-1,815,658	-275,180	NA	
Low – Year 2035								
IOS South	-1,303	-96	NA		-475,068	-34,962	NA	
Bay to Basin	-2,355	-292	NA		-858,935	-106,489	NA	
Blended	-2,819	-356	831	-2,300	-1,026,370	-130,080	308,899	-847,600
Phase 1	-3,301	-409	NA		-1,198,902	-149,450	NA	
High – Year 2030								
IOS South	-2,497	-204	NA		-910,996	-74,341	NA	
Bay to Basin	-3,894	-555	NA		-1,420,703	-202,716	NA	
Blended	-4,362	-642	1,069	-3,900	-1,588,568	-234,200	401,569	-1,421,200
Phase 1	-4,869	-735	NA		-1,769,872	-268,403	NA	
Low – Year 2030								
IOS South	-1,270	-93	NA		-463,088	-34,101	NA	
Bay to Basin	-2,295	-285	NA		-837,275	-103,866	NA	
Blended	-2,748	-348	708	-2,400	-1,000,488	-126,877	247,119	-880,200
Phase 1	-3,218	-399	NA		-1,168,669	-145,769	NA	

Note - Totals rounded to nearest hundred
NA = Not Available

Table 5 – Draft Comparison of Energy Changes for the HSR Blended Alternative – Years 2040, 2035, 2030

Alternative	Energy Daily Changes (MMBtus/Day)				Energy Annual Changes (MMBtus/Day)			
	Autos	Planes	Power	Total	Autos	Planes	Power	Total
High – Year 2040								
IOS South	-33,816	-2,502	NA		-12,336,124	-913,216	NA	
Bay to Basin	-52,727	-6,823	NA		-19,238,243	-2,490,214	NA	
Blended	-59,064	-7,882	14,200	-52,7000 (-9,100 barrels of oil)	-21,511,365	-2,876,970	5,121,000	-19,267,300 (-3.2 Million barrels of oil)
Phase 1	-65,934	-9,033	NA		-23,966,460	-3,297,121	NA	
Low – Year 2040								
IOS South	-17,199	-1,148	NA		-6,270,839	-418,900	NA	
Bay to Basin	-31,081	-3,496	NA		-11,337,835	-1,275,918	NA	
Blended	-37,213	-4,270	9,300	-32,200 (-5,600 barrels of oil)	-13,547,961	-1,558,582	3,414,000	-11,692,500 (-2.0 Million barrels of oil)
Phase 1	-43,579	-4,906	NA		-15,825,357	-1,790,658	NA	
High – Year 2035								
IOS South	-33,013	-2,440	NA		-12,043,248	-890,724	NA	
Bay to Basin	-51,475	-6,654	NA		-18,781,501	-2,428,881	NA	
Blended	-57,662	-7,688	14,200	-51,100 (-8,800 barrels of oil)	-21,000,656	-2,806,112	5,121,000	-18,685,800 (-3.2 Million barrels of oil)
Phase 1	-64,369	-8,811	NA		-23,397,464	-3,215,915	NA	
Low – Year 2035								
IOS South	-16,790	-1,119	NA		-6,121,961	-408,583	NA	
Bay to Basin	-30,343	-3,410	NA		-11,068,659	-1,244,493	NA	
Blended	-36,330	-4,165	9,200	-31,300 (-5,400 barrels of oil)	-13,226,314	-1,520,195	3,414,000	-11,332,500 (-2.0 Million barrels of oil)
Phase 1	-42,544	-4,785	NA		-15,449,642	-1,746,556	NA	
High – Year 2030								
IOS South	-32,257	-2,380	NA		-11,767,360	-868,787	NA	
Bay to Basin	-50,296	-6,491	NA		-18,351,253	-2,369,060	NA	
Blended	-56,341	-7,499	11,800	-52,000 (-9,900 barrels of oil)	-20,519,571	-2,736,999	4,438,200	-18,818,400 (-3.2 million barrels of oil)
Phase 1	-62,894	-8,594	NA		-22,861,473	-3,136,709	NA	
Low – Year 2030								
IOS South	-16,406	-1,092	NA		-5,981,718	-398,520	NA	
Bay to Basin	-29,648	-3,326	NA		-10,815,098	-1,213,842	NA	
Blended	-35,498	-4,062	7,800	-31,800 (-5,500 barrels of oil)	-12,923,324	-1,482,754	2,731,200	-11,674,900 (-2.0 Million barrels of oil)
Phase 1	-41,569	-4,667	NA		-15,095,720	-1,703,539	NA	

NA = Not Available